

Automotive Industries

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Sandy Munro Discusses Pros & Cons of Modularity

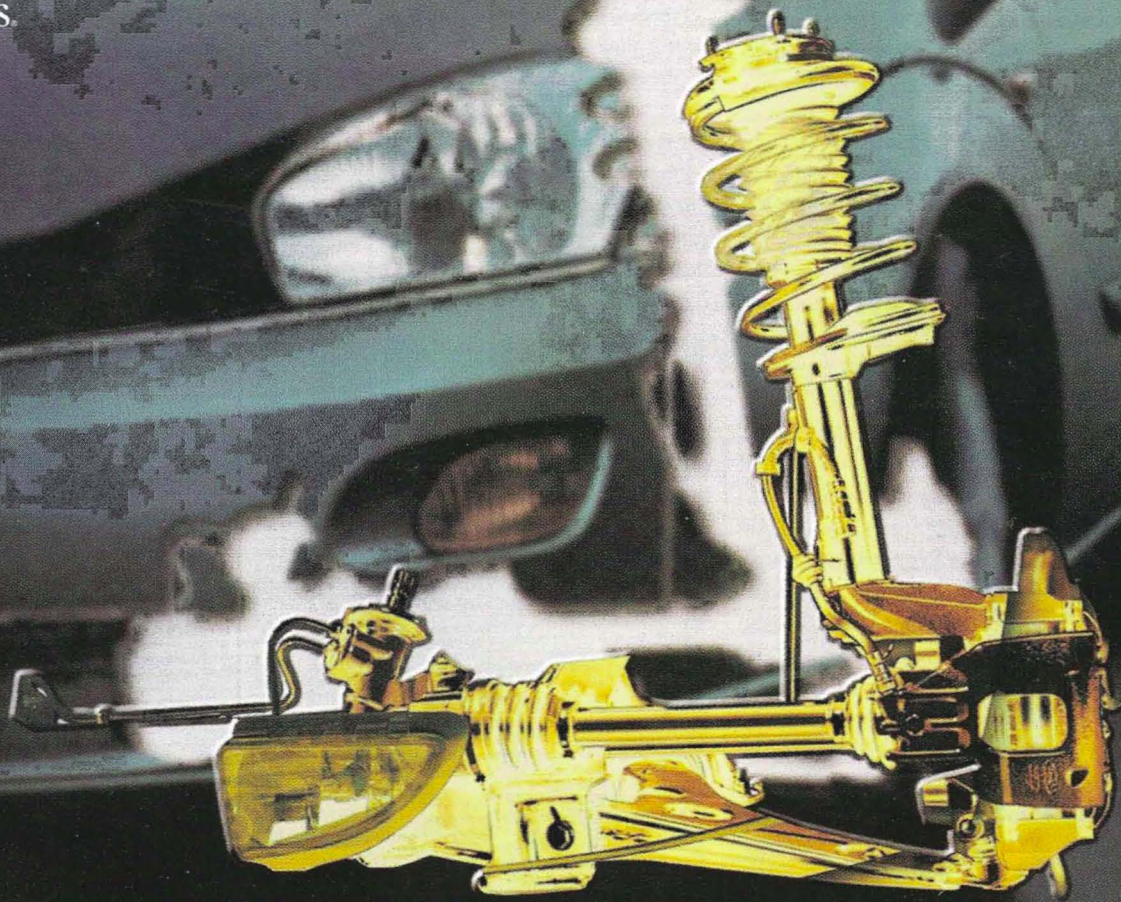
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Modular Mania

 Cahners



**HOW AUTOMAKERS ARE CHANGING EVERYTHING
HENRY FORD TAUGHT THEM ABOUT BUILDING CARS —
AND WHY IT'S GOOD NEWS TO CAR BUYERS. **P. 34****



Modular

It's changing the way cars are designed and built, forcing suppliers to buy up other companies, and scaring the hell out of unions. Ultimately, it will change the way you buy a car.

Linda Dancer was stunned when the Oldsmobile dealer handed her the estimate to repair the power sliding door on her 1996 Silhouette minivan. "They wanted over \$1,000," complains the mother of three, who manages the Fowlerville Fairgrounds in rural Michigan. "We decided not to do it."

Welcome to the world of modular car parts. For nearly a century the auto industry built vehicles from thousands of individual components. If something went wrong with a part it could be repaired or replaced. But today automakers are increasingly making cars and trucks from modules — big chunks of a vehicle that come into an automaker's assembly plant pre-assembled by suppliers. If something goes wrong with a module, such as the mechanism for the power door on Linda Dancer's minivan, the whole thing has to be replaced. That's expensive.

Fortunately for Dancer, the dealer quietly repaired the door for free. But it's a prime example of how the coming "mod squad" world will both change and challenge the industry. If quality isn't perfect, irate customers or warranty costs could cripple a company. Plus, for the 100-year-old auto industry, there is a steep learning curve involved in switching to modular cars made in modular plants.

So modularization is not something automakers are adopting willy-nilly. The stakes are too high. "If you don't dot every 'i' and cross every 't' it could be the ruination of your organization," warns Sandy Munro, president of manufacturing consulting firm

Munro & Assoc. But for those who can make it work, the potential rewards are phenomenal.

Why Modular?

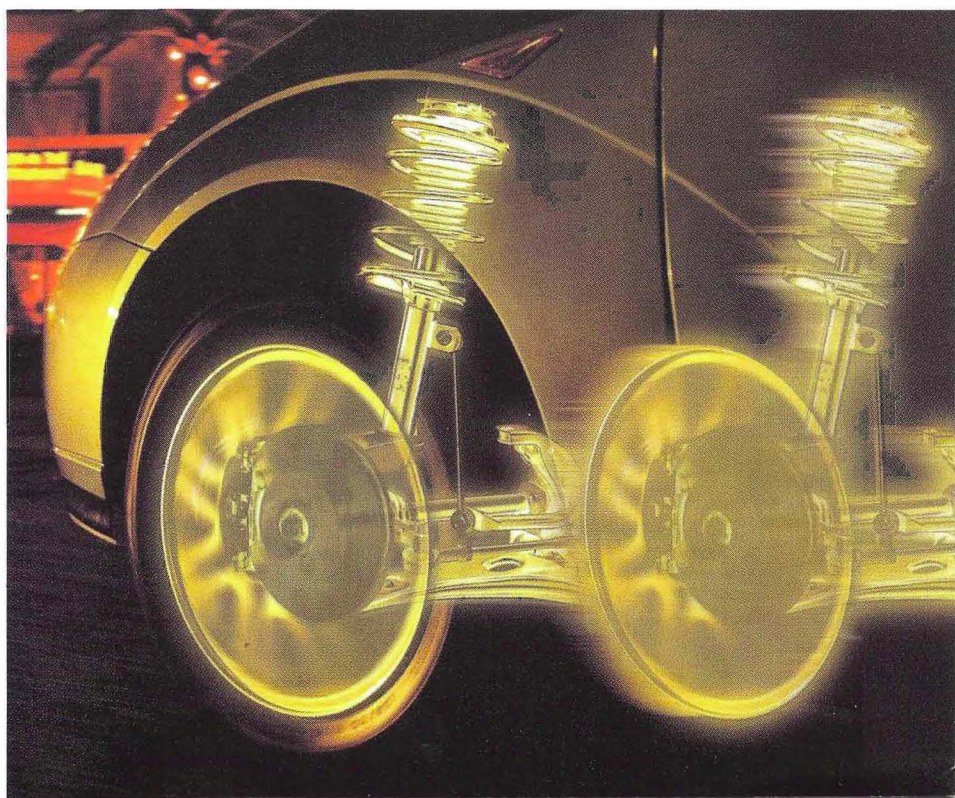
Take a look at the pluses of modularization:

- It could put a stop to ever-escalating vehicle prices. For many consumers cars simply cost too much. To the average American family, purchasing a new car represents half a year's salary. In the past, automakers built or bought all the parts that make up a car, figured out the total cost, then tacked on the profit they wanted to make. That became the sticker price. Today, an automaker must

figure out what a customer will likely pay for a future model and subtract the profit it wants. What's left over is the cost. So the automakers better build a car to that cost because if it doesn't, it's hurting its profit margins.

- Cars and trucks could be assembled quicker. The goal is to get the vehicle in the hands of the buyer in less than a week. Today, it takes about 40 days.

Assembly is faster because less of the vehicle is assembled in the automaker's plant. Suppliers will do that at nearby sites and ship the entire module into the plant, delivering it to the exact location at the exact time it's scheduled to be added to the vehicle. The reduction in parts is impressive. For example, Ford used to assemble about 120 parts to make the instrument panel (IP) for the Escort. Today, the IP for the Escort's suc-



Mania

by the Automotive Industries Staff

WHAT IS A MODULE?

In its simplest form, a module is an assembly made up of different car parts. When the module is bolted onto a car, it allows many different parts to be installed at the same time. It may be a "corner" module that comprises the brake, suspension, shock absorber, wheel and tire. It might be a front-end module that contains the radiator, cooling fan, headlights and bumper. Or it could be a rolling chassis that includes everything needed to make an entire vehicle but the body and interior.

Typically, a module is made up of parts that require different engineering disciplines to interact with one another. That's different than other assemblies. For example, bumper engineers design a bumper assembly but a front-end module requires bumper, lighting, cooling and body engineers.

Different automakers and suppliers have different ideas of how many modules will be needed to make a car. Some say 16, some say 8 and others say three.

One thing's for sure. There is no industry-wide definition.

Says Bill Carroll, president of Dana Corp.'s Automotive Components Group: "Everyone is trying to define what modular is, from a brake corner to a rolling chassis to maybe even a full vehicle. There's no clear answer."

Modular Mania head-on. We explain why suppliers are salivating at the prospects of a modular future — and why some of the industry's best-known experts call modularization "dangerous."

We'll talk to the field marshals who are leading the modular charge, and find out what "going modular" means to their companies' R&D costs, purchasing plans, and manufacturing operations. We'll take you to today's leading modular auto plants, and provide a glimpse of the factories soon to come. And we'll tell you why the modular concept won't blossom without organized labor's blessing.

It's a transformation taking place globally. Here's what Modular Mania's all about.

cessor, the Focus, comes in as a single part.

- Instead of parking 60 days' worth of cars on every dealer's lot, automakers could build cars to order. That would free up billions of dollars in finished goods inventory, cutting car prices while providing automakers with better profit margins.

- The cost of designing, engineering and manufacturing a car will be shifted to suppliers. An automaker still has to pay for that in the piece price, but if there's a recession or the vehicle doesn't sell, the supplier is stuck with carrying the overhead, not the car company.

- Buying modules from suppliers frees up space in automakers' assembly plants. The modules also come in pre-adjusted and pre-tested. That saves all kinds of time and money. When Mercedes-Benz built its new assembly plant in Alabama, it turned to

megasupplier Delphi to provide modular instrument panels for the M-Class sport utility vehicle. That alone saved Mercedes 40,000 square feet of floor space, and between 30 and 70 people per shift.

A Risk Worth Taking

Most of the progress made in auto manufacturing over the last century has been incremental — simply refinements to Henry Ford's classic 1913 assembly line. Toyota's production system of the 1960s took Ford's idea to its most efficient end, and again reshaped automaking on a global scale. Many experts see Modular manufacturing as the Next Revolution, but making it happen in such grand dimensions won't be easy.

There are major obstacles to overcome. Huge costs. Massive restructuring. Control battles between automaker and supplier. And possibly labor war. Indeed, the fear of union resistance in North America is why the real hotbed of modular activity is currently in South America, where unions are weak.

"If it works down there, they'll try to do it up here," predicts Ron Harbour, president of Harbour and Assoc., a Troy, Mich.-based manufacturing consultancy. Such efforts could slow even the most aggressive company's momentum — and damage its product quality in the process. But these are risks that automakers and suppliers appear willing to take, in order to survive and prosper.

Modular Mania: A Special Report

In this special 10-page cover story, *Automotive Industries'* editors tackle





Changes In the Wind

Modularization is shaking up the industry more than Henry Ford's moving assembly line did 100 years ago.

To the average consumer, clicking together a bunch of modules to build a vehicle should be — pardon the pun — a snap. Not so. As automakers start down this road, they're beginning a trend that is more revolutionary than the moving assembly line invented more than 100 years ago.

The entire automotive infrastructure is changing. Suppliers are becoming more powerful and defining vehicles from the very beginning of development programs. Some will go out of business, and those that remain will be heavily involved in partnerships. The number of workers in assembly plants will dwindle — some say between 30% and 60%, depending on the vehicle as they strive to cut waste and costs by up to 25% (see chart).

That's the scene five to 10 years from now, but the drive toward modularization is dramatically changing the industry already. Faced with sliding margins and a never-ending desire to cut costs, automakers are pushing more and more research and development costs into the supply base as they ask Tier One companies to design and build modules.

Changing Supplier Relations

The suppliers' R&D bill is going up, but then so are their sales. "We'll keep our R&D costs around 5% to 5.5% of sales," says Dan Jannette, president of Lear's technology division. But Lear and other Tier One companies that expect to soon become systems integrators — suppliers that create and assemble huge modules for the automakers — are licking their collective lips at the skyrocketing bottom line they envision with modules. For their part, the automakers are drooling over saving in the range of 20% to 30%.

To accomplish those goals, these suppliers are buying up one another and

quickly gobbling up smaller companies with specific expertise. That means they're working with fewer Tier Two and Three suppliers. "We are looking for a 25% reduction in our supply base over the next five years," predicts Lou Salvatore, Lear's purchasing chief. "Our suppliers must also be able to put together a module or system and assemble multiple technologies."

The idea is to "leverage the knowledge of suppliers," says Gary Cowger, who recently left Opel to run General Motors labor relations. "We are co-designing with them from the beginning."

Power Shift

As the suppliers build more of the car, they could become more powerful than the automakers, says Sheila Ronis, president of The University Group, a consultancy in Birmingham, Mich. "The automakers need to figure out what they need to do to keep their core competencies," she says. "If they don't, they will give up control to the suppliers." Other experts don't see such a massive power shift. But they do believe the suppliers will control more of the design and engineering of vehicles.

Other changes are in the wind. Today, all cars and trucks are built in automakers' assembly plants. Perhaps not for long. GM, for example, has launched Project

Yellowstone for modular assembly plants in the U.S. In traditional plants, parts, components and a few modules are added to the vehicle as it glides down the assembly line. At a Yellowstone plant, the vehicle leaves GM's plant at a certain point and moves into an adjacent supplier operation. For example, the entire interior module will be added to the vehicle while it is outside GM's plant.

Ford and DaimlerChrysler also have modular strategies.

And the winner is...

Chrysler will likely lead the move to modularity in North America, predicts Sandy Munro, president of consulting group Munro & Associates. Meanwhile, GM's plan could flop. "It isn't because GM is big and stupid or anything like that," he says. "It's because GM doesn't have a good relationship with the union, period." That is obviously why GM is bringing Cowger back from his whirlwind four-month stint as head of Opel. Cowger is a manufacturing whiz, and GM hopes he can quickly improve its strained relationship with the union. GM's future, and the future of its modular programs in North America, rests squarely on his shoulders.

If GM can patch up its labor relationship, some suppliers believe it will leapfrog all other automakers in moving to modular production to boost its productivity. But that's a big "if."

ISSUE	TREND	OUTCOME
Supplier R&D costs	up	Suppliers do more work but R&D costs continue to average between 3%-6% of sales; sales volume, however, will increase.
Number of suppliers	down	Could decline 25%-40%
Number of workers	down	Could drop 30%-60%
Cost savings	up	Could be 25%



How Modular Plants Work

They're changing the face of automotive production, and more are on the way.

Students of 20th Century auto-making know the names of the great plants by heart. Highland Park. The Rouge. Wolfsburg. Toyota City. In another 100 years, a new list of names may be equally revered — led by Campo Largo, Cassino, Hambach, Melfi and Resende. Like many pioneers in history, these places are virtual unknowns today.

But not for long. They're the modular pioneers.

While the locations may be thousands of miles apart — Campo Largo's in southern Brazil, Hambach is in northeast France — the new breed of modular plants share many key elements. One is the ultimate goal of having suppliers either in the assembly plant, as is being done at Micro Compact Car's Smart car plant in Hambach, or right next to it in a supplier campus, as many in the industry are now doing. Another goal is designing a vehicle that can be assembled using roughly a dozen pre-built modules.

With this set-up, the automaker is responsible for less than 10% of the value-added assembly operations carried out at the plant. Even body and paint shops may be owned and run by suppliers.

A third key goal is ultra-short distances between module delivery, or build-up, and the end product. This makes a compact shop floor. In the Smart plant, a joint-venture between Daimler-Benz and popular watchmaker Swatch, no incoming module or material is less than 30 feet from the assembly line. But it also means that the just-in-time production system *must* function like...well, like a *perfect* Swiss watch. Just building the tiny Smart car requires 100 truck deliveries to the plant each shift. Logistics and materials management are even more critical than in a traditional plant.

Modular production was proven in the

aircraft and shipbuilding industries of the 1940s (*see sidebar, below*), but it was Fiat that first seriously applied modular methods to automaking. In the mid 1980s, the Italian giant launched the Tipo, the Cassino plant and the FIRE series engine for modular assembly.

"It was easy for them to go modular in big volume," recalls Bradley Bump, vice president of the Berkt Group, a technology and management consulting firm. "Fiat was very vertically integrated then. They could

really leverage their suppliers, like electronics supplier Magnetti Marelli, to go along with the modular plan."

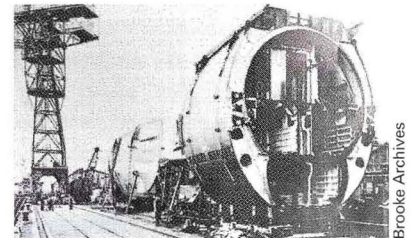
Berkt Group worked with Fiat during the Tipo program of the early 1980s, and helped the automaker map out the car's 14 modules. Bump notes that the Cassino plant and Tipo were launched before processes like design for assembly and systems integration made modular a more attractive strategy.

Because of this, the early Cassino-built Tipos became infamous for poor serviceability — the modules made them expensive to repair.

PLANES AND SHIPS LAUNCH MODULAR MANIA

Automakers began studying the benefits of modular construction before 1920, as *AI* reported in 1916. Some of them adopted elements of it, such as proprietary engine supply, in the early years. But it took the Second World War, and its huge demands on ship and aircraft production to prove modular construction on a grand scale.

In the U.S., modular assembly allowed Henry J. Kaiser to build over 1,200 Liberty and Victory cargo ships, which his yards spit out at the rate of one per day. In 1944, with its coastal shipyards under aerial bombardment, Germany went to modular construction of its latest U-boats. A network of over 30 inland factories built modular hull sections (*photo, right*), which were shipped by river barge to final assembly in three shipyards.



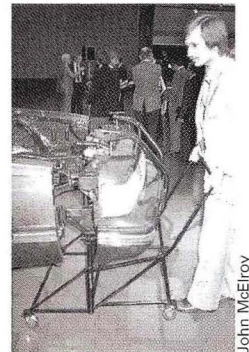
Brooke Archives

Aircraft assembly was even more modular. For example, B-24 heavy bomber production at Ford's Willow Run, Mich., plant was broken down into six subassemblies — center wing, nose, aft fuselage, engines, tail and outer wings, with tail sections built at the automaker's Rouge complex in Detroit. Control modules were assembled off-line. For the Martin B-26, Chrysler supplied center fuselage modules, while washing machine-maker Maytag built many others.

Despite the lessons it learned during the war, the auto industry kept modularity dormant until the late 1970s, when major makers in search of cost savings began hatching modular plans. Fiat struck first in the mid-'80s when it launched its pioneering Tipo model. It featured 14 component modules, a new 1.0L modular engine, and a new assembly plant in Cassino, Italy, designed for the modular production process. At that time, GM was designing its original Saturn cars and considering an entirely modular front end unit (*photo, right*), which it did not employ. Ford's novel 1991 Contour concept car pointed the way to today's major modules, including ducted cooling (by Siemens), front suspension/steering (TRW), rear suspension (Eaton) and modular brakes (ITT).



Brooke Archives



John McElroy

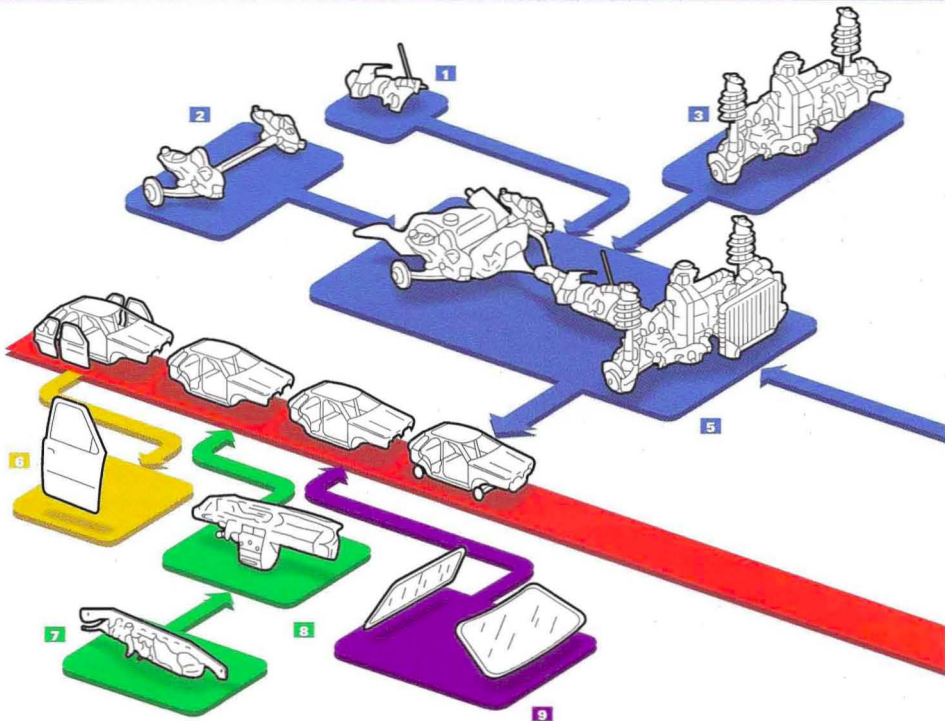


Fiat has taken what it learned at Cassino and is spreading it globally. Its Punto and Palio small cars, built in Melfi, Italy, and Belo Horizonte, Brazil, respectively, employ high modularization. As a result, it takes 12 hours of direct labor to produce a Punto at Melfi, and each employee will build over 70 cars per year, a world-class rate. The level of bought-in modules totals over 70% of the car's value.

Automakers have made their South American operations a beacon for modular assembly. VW was first with its *Consórcio Modular*; the grand strategy of former purchasing and manufacturing czar Iñaki Lopez to make the traditional assembly line obsolete. Lopez launched *Consórcio Modular* nearly two years ago at the automaker's Resende, Brazil, heavy truck and bus plant. But it's a blueprint for worldwide modular manufacturing.

What makes Resende such a pioneer is that the buses produced are assembled as four basic modules — cabin, chassis, engine/transmission and suspension/axles/wheels. The modules are built by suppliers inside the VW plant. The modules are built in cells, or "mini factories," close to the main assembly line. Suppliers have full responsibility for their cells from purchasing to inventory control, tool maintenance, quality, worker safety, wages and even labor grievances. VW provides only the plant's basic utilities such as water, heat and electricity.

THE MODULAR ASSEMBLY PLANT



Provided by Munro & Associates, Inc.

Automakers are moving from today's 14 to 15-module car, to 10 modules — or less, as shown in this graphic of a modularized assembly plant. In some companies' future plans, the bodyshell itself is treated as a module and will be built in body shops run by suppliers. Wheels and tires are being treated as a module today at Mercedes' U.S. plant, which receives wheel/tire "modules" in line sequence from T&WA, a local supplier that pioneered the concept.

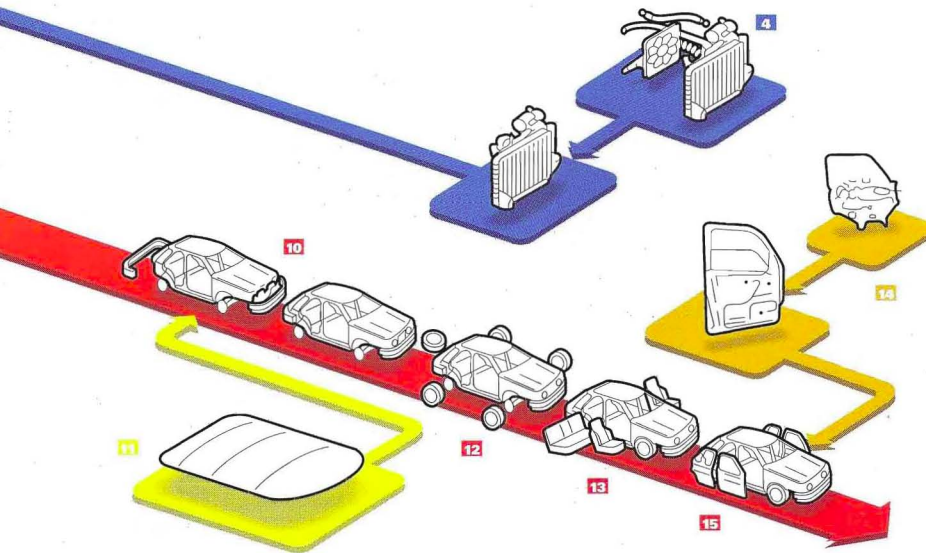
Prime Module	GM U.S.A.	Chrysler	Ford	M-Benz U.S.A.	BMW U.S.A.	Toyota	Honda	VW Mexico*
Front End Suspension	Dana (Blazer)	Dana (Neon, Jeep), Tower	Dana (Ranger)	ZF-Lemforder	ZF-Lemforder			
Front Corners Suspension	Delphi-Saginaw							TRW
Headliner	JCI Prince, Lear, Magna, UTA, Delphi, Irausa	JCI Prince, Lear (Sebring, T&C, Talon)	Becker, Lear (Mustang, Windstar)		Becker	Lear	Lear (Accord, Civic)	Irausa
Cockpit	Lear, Becker, Textron, Delphi, SAL	Textron, Becker (Prowler)	Lear (CDW27), Delphi, Becker		SAL (Z3), VDO, Becker	Becker		SAL
Seats	Lear (25 models)	JCI, Lear	Visteon, Lear		Lear (Z3, M)	JCI	Lear (Passport)	JCI
Door Module Door Plug	Delphi, Lear	Becker, Becker, Lear	Lear	JCI, Becker	Brose			Meritor
Front End			Visteon					Hella
Van Rear Hatch		Lear	Lear					
Front Cooling							Calsonic	Hella
Rear Suspension	Delphi		ZF-Lemforder (Explorer), Visteon	ZF-Lemforder	ZF-Lemforder, Benteler			TRW

The buses built at Resende are obviously simple body-on-frame products with few if any options — perfect for modularity. But VW believes it can spread the gospel into unibody vehicle manufacturing. In this level of modular assembly, the automaker controls the basic body framing, while suppliers take the closure panels (doors, hood, decklid, etc.) and everything else. Even the paint shops the company envisions will be owned and operated by a supplier.

VW plans more modular growth in South Ameri-

SAL: Sommer Allibert; * New Beetle information; Sources: Berk Group, AI (VW info); T&C: Town & Country

- 1 Shifter/brake module
- 2 Rear suspension module
- 3 Powertrain module (includes front subframe, suspension, steering and brakes)
- 4 Cooling module
- 5 Chassis module
- 6 Door remove
- 7 Front bulkhead
- 8 IP module
- 9 Glazing modules (includes windshield and backlite)
- 10 Front end/rear end modules (includes bumpers, lamps, fascias)
- 11 Headliner module
- 12 Wheels and tires
- 13 Front/rear seat modules
- 14 Door inner module (joins painted door outer)
- 15 Door install



ca. Its new Brazilian plant will build Golfs and Audi A3s, which share the same platform. It will also make small trucks using modular assembly in a new Skoda plant in Aratu, Brazil.

Not to be outdone, GM and Ford are bringing big modular plants, with code-names right out of an old Tarzan or Bogart movie. GM's so-called "Blue Macaw" project, starting with a \$600 million plant in Gravatai, Brazil, will build up to 120,000 modularly assembled cars when it launches next year. Ford's recently announced "Amazon" project, in the southern Brazil town of Guaiba, is a \$1 billion investment aimed at producing the B226-code small van in 2001, followed by a modular Fiesta a year later.

Chrysler, Dana Modular Pickups

Like VW's Resende bus plant, Chrysler's new light truck plant in Campo Largo, Brazil, utilizes the potential of body-on-frame for modular assembly. The automaker and Dana

have teamed up to build Dakota pickup trucks featuring a completely modular "rolling chassis." The chassis are built by Dana at a plant five miles from Chrysler's facility, and shipped by truck on the hour to the final assembly line. Soon Durango SUVs will join the program.

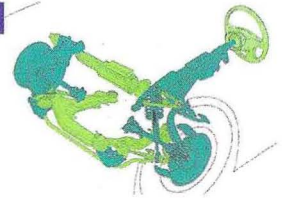
To build the rolling chassis, which is virtually ready for engine/transmission and body installation when it arrives at Chrysler, Dana manages 16 different suppliers. The project allowed Chrysler entry into the Mercosur market (Argentina, Brazil, Paraguay and Uruguay) with very low investment—the plant cost just \$315 million, versus \$1 billion or more for a traditional assembly operation. It's a low-volume operation, geared to build 5,000 trucks this year, rising to 36,000 a year by 2001.

Dana's \$14 million chassis plant on the other side of Campo Largo is also small. It's under 77,000 square feet, compared to the 2.9 million-square-foot Chrysler Warren, Mich., pickup truck plant. The Dana operation employs only 100 people, who man 12 assembly stations.

It's a slow, steady start. Many other plants, and the new vehicle programs slated for them in North America and Europe, are being configured for modular assembly. Clearly, modular auto production is here to stay. The next question is, will it go as far as Ford's mass production did over 80 years ago?

MODULAR ADVANTAGES: FEWER EVERYTHING

The traditional way to build up a front suspension system was to do it part by part, right in the automaker's assembly plant. Now, receiving the complete suspension system as a ready-to-install module offers the following advantages to automakers:



	With Module	Without Module
Number of suppliers	1	50
Number of components/part numbers	1	130+
Number of fastener torques needed	4	54 (1)
SQA visits/certifications per year*	1	50
Production area required (ft ² , x1,000)	0	50
Direct assembly labor (people needed)	2	45
Indirect assembly labor (ditto)	0	14
Engineering change coordination heads	0	2
Module assembly supervision	0	2

* SQA: Supplier quality assurance measures each supplier's quality levels

(1) Four torques to vertically install the module up and into the vehicle

Sources: TRW, GM, Chrysler



The Downside of Modular

Warning to the mod squad: Like every fad that sweeps the auto industry, modularity doesn't live up to its billing with the experts.

Some speculate that soon after the turn of the millennium, modular mania will push the auto industry back to its roots - to when automakers were coachbuilders, assembling big chunks of the vehicle from suppliers' stores. But hold your horses (and buggies). Potentially high costs, questionable quality and severe labor relations problems could put a burr under modularization's saddle.

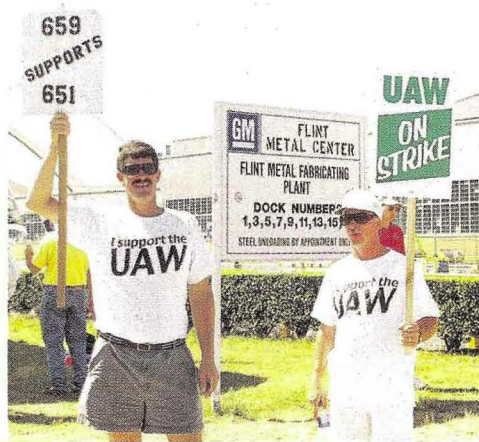
"The modular theory is dangerous," warns Sandy Munro, president of consultancy group Munro & Associates. "It's fine to think of modules, but each one has to make its own business case and many don't. The worst thing you could do is subscribe to the idea that modular is the answer. Then you all run cheering off the edge of a cliff, like a bunch of lemmings." The problem is, there are no concrete facts that prove the modular approach is inherently cheaper, says Jim Harbour, president of Harbour and Assoc., a manufacturing consultancy. "I was just told by one of the top guys at General Motors that everybody is proposing modules now, but the cost is out of sight," he explains. "Chrysler and Ford say the same things to me."

High Cost

To date, highly modular plants trail conventional facilities in efficiency, output and quality.

Modules only make sense when the supplier isn't outsourcing a lot of components, Harbour cautions. Otherwise they are far more expensive and tend to use suppliers not approved by the automaker. "Don't believe anybody that brags about lower cost and higher quality," he adds.

"Either you want to get rid of labor or you are already so inefficient you can't hurt yourself. That's the only two reasons you'd consider going all-modular in volume build. Efficient companies like Toyota, Honda, Ford and others could only go backwards."



Strikes, sabotage and rampant unemployment could negate any of the positive aspects of modular assembly. Suppliers can count on a drive to organize their employees.

Michael Tracy, virtual partner, Munro & Associates, also a consultancy, claims these new "Tier 0.5" suppliers will unwittingly become responsible for the once-confidential safety, warranty and liability issues the automakers try to hide, forcing them to

raise prices or risk going out of business. "The OEM can amortize problems over an entire car when something comes up," he says. "If you've got one tenth of the car and 100% of a safety problem, you're dead."

Labor problems, both salaried and hourly, are even more difficult to resolve. Modularization means fewer jobs for engineers and autoworkers in the auto companies. While some believe suppliers will hire engineers laid off by the automaker in the wake of a move to modular, Harbour disagrees. "Anybody that believes that is nuts," he says. "Modular means you don't reinvent things. The foundation for a modular part is the same for all customers. And suppliers already have all the people they need to do that." (see p. 79.)

On the unionized plant floor level, the picture is even more ominous since some experts predict half the assembly plant workforce could be eliminated. "Clearly the number of people in an assembly plant goes down, but it doesn't necessarily say that the plant where the modules are coming from has a reduction," says Chrysler Chairman Bob Eaton. "Overall it's a redistribution of employment, but not necessarily a reduction," he says.

Harbour speculates that GM's move toward modularization is influenced by the recent UAW strikes. "It's an effort to bust the union," he reasons. "GM only knows how to play hardball. They lost money and now it's payback time."

WHAT'S WRONG WITH MODULAR

Disadvantage	Reason
Cost	Higher freight cost, increased damage, double or triple handling, uncontrolled outsourcing, reduced competition, supplier less efficient than OE, less throughput.
Quality	OE doesn't oversee testing/supplier selection, promotes blame shifting, problems are buried in module, poor engineering integration, elimination of competition.
Labor	Layoffs of efficient manufacturing force, strikes, work slowdowns, lost knowledge, massive unemployment, retaliation/sabotage.
Serviceability	Modules more difficult to replace, repair loops in plants ineffective, more disassembly required, cost of module much higher than single parts.
Knowledge	OE loses competitive advantage, suppliers can become competitor, inability to differentiate product, dependence on supplier for innovation.

Source: Harbour and Assoc., Munro & Assoc., The Agile Group



Suppliers Primed To Pounce

Chassis and suspension systems are ripe for the next manufacturing revolution. Interiors are already there.

Suppliers that can't produce modules will lose control of their destiny, and, perhaps, even their companies. There's no way around it.

"There's no other option, modules are the way forward," says Frank Boccabella, a TRW vice president. "If we don't get into the modular business then we're going to be relegated to a Tier Two status, which means we will not be supplying directly to the OEM (Original Equipment Manufacturers). And it gives that Tier One supplier the option to control (which Tier Two and Tier Three companies) it wants to supply the components."

Many industry experts expect the move to modular manufacturing will dramatically shrink the number of Tier One suppliers. As suppliers merge with or acquire each other to increase their capability to make modules, there will simply be fewer suppliers left. Experts predict the number of Tier Ones will shrink from approximately 3,000 today to just 150 within the next decade. And the 50 largest are likely to emerge as the dominant players.

So the race is on. Interior megasuppliers began the rush to modularization a few years ago, and continue to lead the way. The next breakthroughs will probably come from suppliers of suspensions and structural parts. For example, Ford's next redesign of the Explorer, which will debut in 2001, will feature a modular multilink independent rear suspension developed completely by the supplier.

New Modules

"We've just done a 'black box' design proposal for a rear suspension module that includes brakes, shocks, differential — everything except the four bolts to attach it to the vehicle at the assembly plant,"

says Tower Automotive's Marv Hyma. TRW claims its suspension and steering module, which it already supplies in Europe, triples productivity, reduces rejects 98%, cuts inventory 95% and reduces manufacturing floorspace 60%.

Dana pioneered the rolling chassis with its Brazilian Dodge Dakota plant. Now other chassis systems suppliers want a



Siemens' induction module, aimed at a 2003-model V-8, combines air-intake, engine-control and fuel-delivery systems.

piece of the action. Visteon will begin building a rolling chassis for rear-wheel-drive trucks. For cars that use front-wheel-drive, TRW has offered to attach engine accessories and transmissions, front crossmembers and corners. If that idea sells, the next step would be to install the coolant and fan system.

"Automakers are used to working with billion-dollar program budgets. We're not, so we improvise and are forced to do things more cost-effectively," explains Clive Spackman, TRW vice president of linkage and suspension systems.

Plans are also in place to implement the once-unimaginable concept of a supplier providing the entire interior of a car. "We'll

see complete interiors soon," predicts Matt Ospeck, executive director of marketing and planning for Magna's Symatec system-integration unit. "We're close to the idea of an interior as a single part number." Visteon, for example, showed a single-module cockpit at the recent Paris Auto Show.

What's Inside

Sommer Allibert will assemble complete doors, including all trim, inside an OE plant by 2002. "All our modules are designed so you can replace any single part," says Georg Laukart, SAL vice president for North American sales and marketing. "It must be easier and less expensive to repair, so that the customer sees the benefits as well as the manufacturer." A supplier providing either chassis or interior modules should be able to reduce both cost and weight by 30%, says Mark Glasson, Lucas/Varity Body Systems director of business development. He predicts by 2003, 26% of instrument panels and 33% of steering systems will be supplied as modules.

Similarly, Siemens has developed an engine module that incorporates everything above the intake ports into a single outsourced unit. Developed for a 2002-model V-8, it includes engine control, fuel delivery, air intake and filtration. Siemens designed the reinforced nylon-6,6 module to minimize noise and maximize torque.

There's no telling how far automakers and suppliers may push the idea of modularization on vehicles bowing after 2003. We won't have a real handle on the strategy until after the shakeout in the supplier community is completed, probably shortly after the turn of the century. After that, look for the suppliers to not only control, but create their own destinies.



The Mod Squad Takes Over

The final path to modular mania is not set in stone. But one thing is clear — it is the future of the industry.

Picture this. You walk into a dealership, point out the vehicle you want, sign the papers and three days later it's sitting in your driveway. Miracle of miracles? No, that's the future, thanks to today's push to build vehicles out of modules. No more waiting 40 days for your car or truck.

Automakers that can get cars into the hands of impatient buyers in less than a week are the winners in tomorrow's marketplace. That means a better bottom line and stronger margins, but it also means an entirely new auto industry. Manufacturing techniques will change along with employment levels, supplier input and labor relations. There are caveats, too, including engineering turf wars, lack of global standardization and battles with the unions.

Even so, several modular plants will be on stream in the 2001 to 2002 timeframe. By 2005 to 2010 modular production could explode and become the most efficient, and profitable, way to make cars and trucks, predicts Dan Jannette, president of Lear's technology division.

Automakers that need to be more efficient at assembly are pushing modularity. "That's one of the reasons why you don't see the Japanese leading the charge here," says Lance Ealey, an automotive specialist with consultant McKinsey and Co. "What you do see is a lot of Europeans leading the charge, with the Americans kind of falling in between." Fiat and Volkswagen, for example, are heavily into modular production in South America and are, today, the industry's leaders. Similar ideas are on the drawing board at General Motors, Ford and DaimlerChrysler.

"The industry is saying, 'Okay, this is about as far as we can go using conventional technology,'" says Dave Cole, director of the Office for the Study of Automotive

Transportation. "What's the next step?"

Future Factories

Experts suggest the factory of the future will likely be packed with suppliers making modules with employees who are virtually indistinguishable from auto company workers, except they may be paid less. One option is known as the "straight gut" factory where suppliers would make modules in what are essentially roped-off areas along one long line in the assemble plant. Suppliers would build their modules and drop them straight into the car. "When we did the financials, it was unbelievable," says Sandy Munro, president of Munro and Assoc., an automotive consulting firm. "Everybody wins, in theory." However, he points out, each module must make its own business case. "When a module makes sense I am pro-module; when it doesn't, I am anti-module."

With the automaker owning the building and suppliers basically renting space, costs for heating, cooling and shipping go away. "Suppliers would look after their own little part, and whoever is in charge of that is going to micro-manage it to the max," Munro says. Suppliers will also have a stronger voice in designing the plant, a role traditionally left to the automakers.

That is crucial to interior suppliers because they want to supply complete interior modules. That is a problem that could hold up modularity. "Every one of the big interior guys can show up with an entire package," says Munro. "The big problem is getting that package into the vehicle in one big lump." One solution could come from an experimental plant that Mercedes considered years ago. In its current incarnation, the top of the car comes off. Known as a "clamshell car," the interior is dropped vertically and followed by the roof, which could be attached using

structural adhesive.

"You can get a whole car made out of plastic now, so making the roof out of a composite and gluing it in after the interior is in place isn't anymore unlikely than taking a lot of black goop and swapping out a windshield. They do that everyday," he says.

Some have even conjectured that one day there may be only three vehicle modules — chassis, interior and exterior. "I don't think we're talking about anything that extreme yet," says Cole. At least for awhile it will be more like 15 to 20 modules, and that will happen very soon, predicts Hans Schardt, global manufacturing chief for Ford's new Focus, which is already very modular.

Supplier Involvement

As that happens, the Tier One suppliers will be the major suppliers of all the sub-systems, says Sheila Ronis, president of The University Group, a management consulting firm. Meanwhile, the automakers will be responsible for some of the design characteristics, or listening to the voice of the customer. But they're not really going to be designing and engineering modules, she says.

"There's no escaping the big change that's upon us," Ronis says. "The challenge is going to be the OEMs' ability to create the kind of partnerships they're going to need with their suppliers. For American companies that's not their strength — it's one of their strategic weaknesses."

For their part, suppliers are hoping to create modules that could be used by several automakers. That cuts costs, saves time and boosts profit. That potential always exists, says Roman Krygier, vice president of advance manufacturing engineering at Ford. "There's probably going to be some degree of standardization," he predicts, "but I'm not exactly sure where that will fall. We all still want to have our differentiation in the key areas for competitive advantage." Each module is unique to

a vehicle, adds Chrysler President Tom Stallkamp. "(Daimler and Chrysler are) trying to find component commonality, but we're not really looking for the door module that goes across Chrysler products, let alone Daimler's." Still, there are some niches that could be broad-based, though, such as ABS systems. Other top contenders, Stallkamp suggests, might be navigation and entertainment systems.

Employment Cuts

No matter how it shakes out one thing is for certain. There will be fewer people working in the automakers' assembly plants and on their engineering and purchasing staffs because more of those duties will be handed over to the suppliers.

That means turf wars and, possibly, a slower move to modularity while that's sorted out. "You're talking about their jobs now," says Bradley Bump, vice president of the Berkt Group, a research firm. "When you talk about outsourcing engineering or purchasing responsibility to a megasupplier, (the automakers) don't want that. They'll try to find a way to keep those jobs in-house."

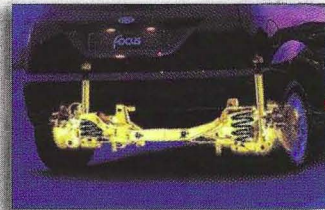
The same is true for the UAW, which will fight vehemently to stop workforce cuts in the plants, unless it can reach an agreement with the automakers. It's possible that as an enticement the auto companies could pressure the suppliers to let the union organize their operations. It would seem a small price to pay for labor

peace and a more efficient way of building vehicles.

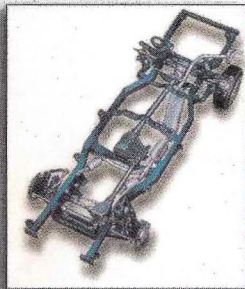
"The only way to get through this is to sit down and think it through together," says one UAW official. "You must figure this out before the 60 days of bargaining." That's next June for Ford, GM and Chrysler. Because of that, labor experts predict this next round of bargaining will be extremely difficult and will determine the future of modular production in the United States.

Whether or not American unions support it, Modular Mania will certainly flourish wherever automakers can use its full potential. Those companies that do will own the future, while their customers enjoy new, built-to-order cars and trucks delivered in a week — or less. ■

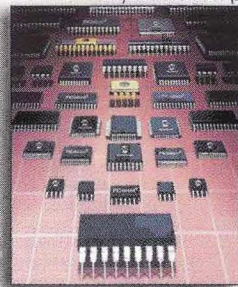
THE FIVE-MODULE CAR They'll be assembled like the scale-model kits you built as a kid, and may even include a drop-in "pod" interior.



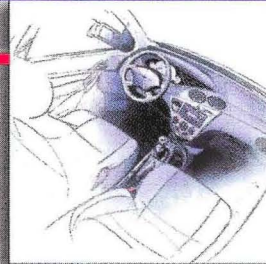
REAR-END: Incorporates brakes, suspension, drive axle, rear subframe and possibly fuel tank, and arrives fully adjusted, ready to bolt onto the chassis or body.



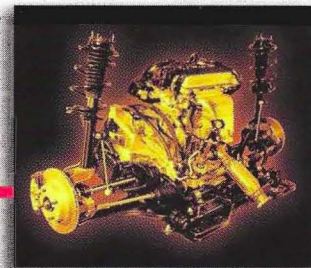
CHASSIS: Light trucks with body-on-frame construction will be built on rolling-chassis modules, such as Dana and Chrysler are now pioneering in Brazil.



ELECTRONICS/WIRING: A single module, integrating the control electronics, wiring and all hardware, will service the entire vehicle.



INTERIOR: The concept of the total interior module — a "pod" that can be virtually dropped into the body — will move closer to reality.



FRONT-END/POWERTRAIN: A common subframe will mount the engine (itself wearing a modular induction system) and front-drive, with suspension, brakes and cooling module.



FRONT CLIP: Complete front-end modules, including lamps, fascia, bumper and perhaps cooling module will be bolt-on affairs. Saturn considered such a unit in its early phase (see sidebar, p.38).

Thinking about going modular?

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